Remarks/Arguments

Applicant has reviewed the Examiner's comments with respect to the subject application and has the following comments.

Claim 1 has been amended to include the following feature: "wherein each of said first and second statistical relationships is configured to guide the valid variations of the respective model object based on a respective set of training images". Basis for this amendment can be found, for example, on page 17, lines 12 to 14 of the application as filed. It is stated therein that the training module is used to determine the relationships between the model parameter displacements and the residual errors for each of the models to guide what are valid shapes and intensity variations from a set of training images.

35 USC 102(b) Rejection

Applicant notes the rejection of claims 1-6, 11-13, 15-18, and 27-29 as being anticipated by Sheehan et al. under 35 USC 102(b).

As stated on page 1 of the present application as filed, known art modelling systems are disadvantageous because they do not verify the presence of a particular target object in images that are to be represented by a modelled object class. A further disadvantage of prior art modelling systems is that they do not consider, let alone identify, the best model object to use for a specific image. For example, in medical imaging a requirement is to segment pathological anatomy in a, which typically demonstrates significantly more variability than physiological anatomy. A side effect in prior art modelling systems which model all the variations of pathological anatomy in a single representative model is that the model object can "learn" a wrong shape with respect to a target object and consequently will find a suboptimal solution for fitting the model object to the target object. This is often caused by a generalisation step that occurs during a learning phase of prior art modelling systems which enables a model object to

learn example shapes from example training images that could not exist in reality.

The invention according to the present application overcomes the above-discussed disadvantages associated with prior art systems. The image processing system according to claim 1 applies a plurality of different model objects to the same image in order to determine which of the respective model objects results in the best fit of the target object present in the image. Each of the respective model objects includes a statistical relationship based on a respective set of training images, resulting in different shape and texture configurations for the different statistical relationships. By using the different models and selecting the model which best fits the target object the system according to claim 1 serves to prevent the determination of shapes that could not exist in reality.

By way of practical example, the case of segmenting a human pelvis may be considered. The shape of the pelvis depends on the gender of the patient being imaged, wherein male pelvises tend to be tall and narrow while female pelvises tend to be short and wide. Accordingly, a single model combining both male and female cases would contain the whole spectrum of variation (tall, short, narrow and wide) such that the single model would have great difficulty in trying to identify deformities in a distinctly male or female pelvis. For example, it might erroneously determine that a pelvis which is both and tall and wide is within the valid variations of the object being modelled. In contrast to this, if the system according to claim 1 is utilised wherein a first model object corresponding to a male pelvis and a second model object corresponding to a female pelvis are both applied to the same digital image, regardless of any pathological defect in the pelvis being imaged, one of the two model objects will correspond to the target more closely than the other. Each of the male model and the female will have a small covariance in absolute value whilst a single model representing both male and female images would have a larger covariance in absolute value. Therefore by having the two distinct gender models and selecting which one is more

appropriate to apply to an image containing a target object, any defect or particular pathology present in the target object will be more easily identifiable.

The model object according to claim 1 includes information on the average shape and texture of the object and statistical information on the allowed (i.e. valid) variation of the shape and texture away from their averages. Model objects according to claim 1 therefore contain all the information necessary to generate deformations in order to fit or explain a target object in a patient image. No prior art system employs a plurality of model objects containing such information, and certainly none compare and select model objects in the manner according to claim 1. Furthermore, no prior art modelling system discloses or suggests defining model objects based on a select population, i.e. on a selected set of training images, but instead determine a less effective model over a large and diverse set of training images from a diverse population.

It is noted that in certain prior art modelling systems the model changes geometric information during the process to fit, i.e. segment, an image. However, this respectfully should not be construed as using different model objects in accordance with claim 1, since the model object in claim 1 contains both shape and texture and the statistical information which provides knowledge of how (i.e. valid) to change said shape (i.e. geometry) and texture in order to fit an image being modelled. The prior art model objects themselves do not comprise such knowledge.

It will be appreciated from the above that the invention according to claims 1, 27, 28 is neither disclosed nor suggested by prior art teachings. Thus it is submitted that claim1 is both novel and inventive over the teachings of the prior art.

Accordingly, Applicant considers the rejection of claims 1-6, 11-13, 15-18, and 27-29 as being anticipated by Sheehan et al. under 35 USC 102(b) as hereby overcome.

35 USC § 103(a) Rejection

Applicant has reviewed the rejection of claims 7-8, 10, and 14 by the Examiner according to 35 USC § 103(a) as being unpatentable over Sheehan et al. in view of Steven C. Mitchell, Boudewijn P.F. Lelieveldt, Hans G. Bosch, Johan H.C. Reiber, and Milan Sonka.

Applicant believes the rejection of claims 7-8, 10, and 14 are moot in view of claim 1 amendments.

Further, as discussed above, cited art does not show that in certain prior art modelling systems the model changes geometric information during the process to fit, i.e. segment, an image. However, this respectfully should not be construed as using different model objects in accordance with claim 1, since the model object in claim 1 contains both shape and texture and the statistical information which provides knowledge of how (i.e. valid) to change said shape (i.e. geometry) and texture in order to fit an image being modelled. The prior art model objects themselves do not comprise such knowledge.

Applicant submits in view of the above discussion that the rejection of claims 7-8, 10, and 14 by the Examiner according to 35 USC § 103(a) as being unpatentable over Sheehan et al in view of Steven C. Mitchell, Boudewijn P.F. Lelieveldt, Hans G. Bosch, Johan H.C. Reiber, and Milan Sonka as hereby overcome.

Conclusion

In light of the above amendments and remarks, applicant submits that the claims are in condition for allowance, and request that the outstanding rejections be withdrawn. If a telephone conference would expedite allowance of the claims, the Examiner may wish to telephone Applicant's Patent Agent at (416) 862-4318.

Respectfully submitted,

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